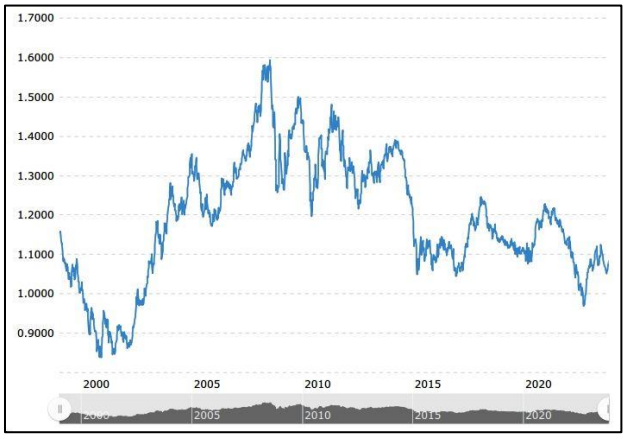
CSCE 2211 Spring 2024 Applied Data Structures
Assignment #5

Dr. Amr Goneid ***Date: Mon April 15, Due: Thu April 25, 2024***

Analysis of Financial Time Series: EURO/USD Exchange Price

You are given the daily EURO/USD exchange rates over the period from January 4, 1999, to November 16, 2023 (at www.macrotrends.net. A follow-up link is:
https://www.macrotrends.net/2548/euro-dollar-exchange-rate-historical-chart)
The historical data are provided in the file "euro-dollar.xlsx". The size of this dataset is $n = 6668$ data points.



An exchange rate point may be represented as ***x(i), i = 1….***n. The average exchange rate over the given period is:

$$M = \frac{1}{n}\sum_{i=1}^{n} x(i)$$

A change ***C(i) = x(i) – M*** is positive when the rate rises over ***M***, and it is negative when it drops below that average. A graphical chart of the exchange rate time series is given in the figure.

Problem (1):

From the given data set, **we need to find the dates** of each of the N most positive changes (e.g., N = 10) as they represent the N highest exchange rates over the whole data set. Likewise, **we need to find the dates** of each of the N most negative changes (e.g., N = 10) as they represent the N lowest exchange rates over the whole data set.
This problem can be solved using ***Binary Heaps*** where a node represents the amount of change ***C(i)*** of the exchange rate from the mean ***M*** at a given day. In this case, each item is composed of 2 elements: the date and the exchange rate change ***C(i)*** from the average. Priority here is for the exchange rate change.

Problem (2):

We also need to find the start date and the end date of the ***contiguous*** period over which the ***sum of rate changes*** is maximum.
This problem is called the ***Maximum Subsequence Sum Problem.*** The problem statement is as follows:
Given a sequence of numbers (possibly negative), ***C(1), C(2),…C(n),*** find the values of the indices ***(i, j)*** that maximizes the value of the sum:

$$S = \sum_{k=i}^{j} C(k)$$

(This is zero if all values are negative).

Example: Suppose the changes in exchange rate are given by the sequence ***[C(1), C(2)…C(5)]*** = (**- 0.2, 1.1, - 0.4, 1.3, - 0.5, - 0.2**). Then, ***Smax = C(2) + C(3) + C(4) = 2.0 and (i = 2 and j = 4).***

An efficient algorithm for the ***Maximum Subsequence Sum Problem*** is given in the course slides: http://www1.aucegypt.edu/faculty/cse/goneid/csce2211/CSCE 2211 Part 3b Complexity.pptx

Required Implementations:

1. Implement the ***Build_Max_Heap*** and ***Build_Min_Heap*** functions ***using the Heapify algorithm.*** **DO NOT USE ANY SORTING OPERATION**

2. Implement the ***Maximum Subsequence Sum Algorithm.***

3. Implement and execute a program to find the ***N highest and N lowest exchange rate days*** over the whole data set (e.g. N = 10). Your Program should also find the ***start and end days*** of the ***contiguous*** period over which the ***sum of rate changes*** is maximum.

4. ***Provide an analysis*** of the algorithms used and the total complexity of your implementation as a function of the size of the data given.

Delivarables
1. C++ codes for all functions and the program used.
2. A text file containing the results obtained from the program runs. The file should also provide the analysis required.